Radioactive background analyses

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Major physics backgrounds in the SNO detector come from radioactive decays of various nuclei in Uranium and Thorium decay chains. Among these decays, decays of ^{208}Tl and ^{214}Bi nuclei have largest effects on neutrino signals because these two decays have largest Q values in their respective decay chains and, more importantly, their decay products have gamma rays with energy higher than 2.223Mev which can produce free neutrons through photo disintegration of deuteron.

It is important to determine the number of these two decays as background levels in the detector determine the detector threshold and also are critical for correct interpretation of number of NC events seen by the SNO detector. The SNO collaboration has developed a complex water assay technique to measure U/Th concentration levels in both the heavy and the light water. We developed a completely different technique to determine background levels in the SNO detector directly. Basic idea of the technique is to use difference between hit patterns of the ^{208}Tl and the ^{214}Bi decays (as shown in figure 1 where θ_{ij} is a paramter used to describe isotropy of a hit pattern) to distinguish between two types of decays statistically, and then MC can be used to deduce background event rates.

Main advantages of such technique are:

- It is capable of determining background levels in situ and at real time.
- Unlike the water assay technique, it directly measures rates of most important decays: the ^{208}Tl and the ^{214}Bi decays so that it doesn't need to make assumption of secular equilibrium within the decay chains.
- This technique is completely different to those used in the water assay so that it is subject to completely different systematics and its results can be compared with results of the water assay to produce a fairly robust estimate of background levels in the detector.

We have applied this technique to analyze data taken during D_2O phase of the SNO experiment. The results are in good agreement with the results of the water assay. The ^{24}Na source, which is essentially a containerless source, has been deployed to quantify systematics of the technique.

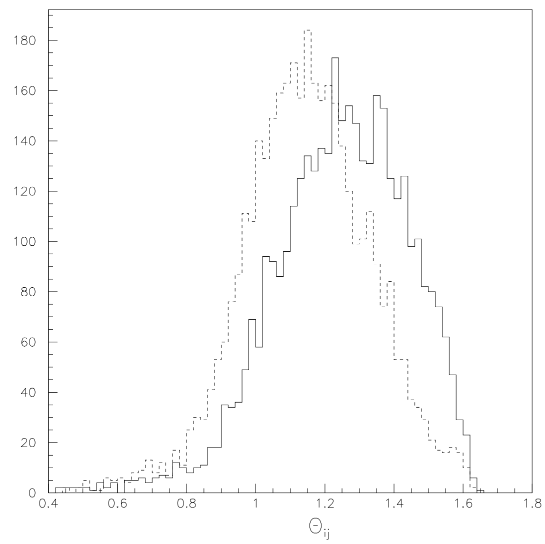

Figure 1: θ_{ij} distributions for ^{208}Tl (solid line) and ^{214}Bi (dashed line) decays in the heavy water.

References

[1] LBNL SNO Group; Preliminary Studies of low Nhits data, SNO-STR-99-029, 12/7/1999.